

REMARKS

This paper responds to the Advisory Action dated August 1, 2006, and the Final Office Action dated on May 17, 2006. This response is in addition to the remarks presented to the Final Office Action dated May 17, 2006, which is incorporated herein by reference.

No claims are amended, no claims are canceled, and no claims are added; as a result, claims 1, 2, 5-10, 13-15, 18-23, 26-31, 34-37, 51, 52, 54-56, and 62 are now pending in this application.

§103 Rejection of the Claims

Claims 1-2, 4-6, 14-15, 17-20, 51-52, 55-56 and 62 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Ma (U.S. Patent No. 6,207,589) in view of Park (U.S. Patent No. 5,795,808) and Yano (U.S. Patent No. 5,810,923). Applicant respectfully traverses this rejection and respectfully requests that the Examiner respond to the following points of Applicant's discussion.

The cited reference of Ma discloses a metal oxide gate dielectric formed of either Zr or Hf alloyed with about 25% of a trivalent metal such as aluminum or lanthanum, formed by sputtering in an oxygen ambient. The final structure has an interface barrier 62 having a thickness 64 of typically 2-5 angstroms. The interface barrier 62 is formed of silicon nitride or silicon oxynitride (see col. 2, line 17 and col. 6, line 9 and figures 12 and 13). Park is used to show that sputtering and evaporation are art recognized equivalents. Yano is used to show that the deposition temperature range, the use of atomic oxygen, and that smooth metal oxide surfaces are known.

The first point is that Ma does not teach the use of electron beam evaporation, or a smooth surface, which the Examiner admitted in the Office Action mailed on November 4, 2005. Applicant submits that the use of sputtering is not the same as electron beam evaporation, as the smoothness of the surface of the semiconductor to metal interface is different, as discussed in the present specification at least at page 3, lines 9-24, and figures 2 and 3, wherein it shows that sputtering, such as used by Ma, causes pits 240 in semiconductor body region 200. Since the present claims call for "... *evaporation depositing a substantially amorphous and substantially*

single element metal layer directly contacting the body region using electron beam evaporation...”, as recited in claim 1, and since it has been shown that there is at least a difference in surface roughness between sputtering and electron beam deposition, then the primary reference of Ma teaches away from the claimed method.

The second point is that Ma teaches a method of forming a doped metal oxide dielectric film, in particular zirconium doped with a trivalent metal such as aluminum, as may be seen in the title, the abstract, col. 1, line 64; col. 2, line 37; col. 3, line 59; col. 4, line 24; col. 5, line 65; col. 6, line 51; col. 7, line 10; claims 1, 5, 6, 7, 11, 12, 13, 14 and the last claim 15. Applicant respectfully submits that there is no suggestion in the combination of the cited references, whether taken alone or in any combination, to one of ordinary skill in the art to use a pure metal rather than the trivalent metal doped film of Ma. Ma states at least at col. 1, line 34 that “One common problem associated with the above-mentioned high-k dielectrics is that they develop a crystalline structure under normal preparation conditions. As a result, the surface of the film is very rough. Surface roughness causes non-uniform electrical fields in the channel region adjacent the dielectric film. Such films are not suitable for the gate dielectrics of MOSFET devices.” Ma teaches that adding trivalent materials reduces the tendency to crystallize, and suggests 25% to 50% of aluminum as the correct region at col. 2 lines 1-3. Thus, there exists no possible motivation to use the recited “...*substantially amorphous and substantially single element metal layer directly contacting the body region using electron beam evaporation ...*”, as found in claim 1, since nothing may be found in the primary reference that teaches the use of heavily trivalent doped metal layers.

The third point is that the present claims recite “...*oxidizing the metal layer to form a metal oxide layer directly contacting the body region ...*”, as found in claim 1. The primary reference of Ma teaches sputtering in an oxygen ambient and argues against oxidizing a deposited metal layer, as causing crystallization of the oxide, as noted in the previous paragraph. Ma also states at least at col. 1, line 45 that “high temperature post deposition annealing and the formation of an interfacial SiO₂ layer, make achieving equivalent SiO₂ thickness (EOT) of less than 1.5 nm very difficult”, again arguing against the claimed method of oxidizing an electron beam evaporated pure metal, since it may form a parasitic SiO₂ film at the interface.

The fourth point is that Ma discloses an interface barrier 62 of 2-5 Å of silicon nitride or silicon oxynitride (see col. 2, line 17 and col. 6, line 9 and figures 12 and 13), while the present claims call for “...*oxidizing the metal layer to form a metal oxide layer directly contacting the body region...*”, as recited in claim 1. Ma teaches that with the interface barrier “... the channel region top surface is made smoother to prevent the degradation of the electron mobility of the MOSFET ...” (col. 2, lines 16-18), which Applicant submits as further proof of the known difference between sputtering, such as disclosed by Ma, versus the electron beam evaporation of the present embodiments. Thus, Ma either admits that the surface is not smooth, or that the metal can not be deposited directly on the channel surface, the body region.

In general, Applicant respectfully submits that there is no suggestion to one of ordinary skill in the art to use a pure metal rather than the trivalent metal doped film suggested by Ma for minimum crystallization and parasitic SiO₂ interface films. By contrast to Ma, the present specification explains that the material to be evaporated is 99.999% pure zirconium. One of ordinary skill in the art would not understand Ma to be teaching a pure metal. Ma repeatedly discusses the use of a trivalent metal alloy, which would not suggest the use of very pure materials to one of ordinary skill. Applicant respectfully requests that the Examiner provide some objective teaching from the cited references showing motivation to suggest changing the trivalent alloy metal to the pure metal of the present application. In the same line of argument, Applicant submits that the cited references do not suggest the combination of a pure metal, electron beam evaporated to directly contact the body region, and oxidized to form a dielectric directly contacting the body region. Applicant submits that the Examiner has the burden under 35 USC § 103 to establish a *prima facie* case of obviousness with respect to at least these four points. *In re Fine*, 837 F.2d 1071, 1074, 5 U.S.P.Q.2d (BNA) 1596, 1598 (Fed. Cir. 1988).

CONCLUSION

Applicant respectfully submits that the claims are in condition for allowance and notification to that effect is earnestly requested. The Examiner is invited to telephone Applicant's attorney David Suhl at (508) 865-8211, or the undersigned attorney at (612) 349-9587 to facilitate prosecution of this application.

If necessary, please charge any additional fees or credit overpayment to Deposit Account No. 19-0743.

Respectfully submitted,

KIE Y. AHN ET AL.

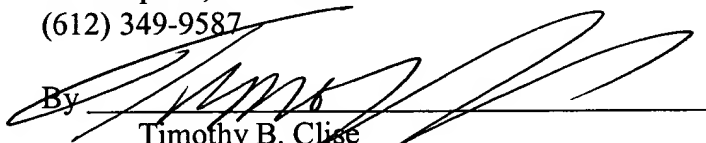
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17 Aug '06

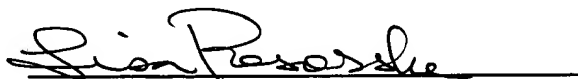
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